

$$Q_{sd} = 3,600(1 - B_{ws})(v_{a(avg)})(A) \left(\frac{T_{std}}{T_{s(avg)}} \right) \left(\frac{P_s}{P_{std}} \right) \quad \text{Eq. 2F-11}$$

13.0 Method Performance. [Reserved]

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 Reporting

16.1 Field Test Reports. Field test reports shall be submitted to the Agency according to applicable regulatory requirements. Field test reports should, at a minimum, include the following elements.

16.1.1 Description of the source. This should include the name and location of the test site, descriptions of the process tested, a description of the combustion source, an accurate diagram of stack or duct cross-sectional area at the test site showing the dimensions of the stack or duct, the location of the test ports, and traverse point locations and identification numbers or codes. It should also include a description and diagram of the stack or duct layout, showing the distance of the test location from the nearest upstream and downstream disturbances and all structural elements (including breachings, baffles, fans, straighteners, etc.) affecting the flow pattern. If the source and test location descriptions have been previously submitted to the Agency in a document (e.g., a monitoring plan or test plan), referencing the document in lieu of including this information in the field test report is acceptable.

16.1.2 Field test procedures. These should include a description of test equipment and test procedures. Testing conventions, such as traverse point numbering and measurement sequence (e.g., sampling from center to wall, or wall to center), should be clearly stated. Test port identification and directional reference for each test port should be included on the appropriate field test data sheets.

16.1.3 Field test data.

16.1.3.1 Summary of results. This summary should include the dates and times of testing and the average axial gas velocity and the average flue gas volumetric flow results for each run and tested condition.

16.1.3.2 Test data. The following values for each traverse point should be recorded and reported:

- (a) P_1 - P_2 and P_4 - P_5 differential pressures
- (b) Stack or duct gas temperature at traverse point i ($T_{s(i)}$)
- (c) Absolute stack or duct gas temperature at traverse point i ($T_{s(i)}$)
- (d) Yaw angle at each traverse point i ($\theta_{y(i)}$)
- (e) Pitch angle at each traverse point i ($\theta_{p(i)}$)

(f) Stack or duct gas axial velocity at traverse point i ($v_{a(i)}$)

16.1.3.3 The following values should be reported once per run:

- (a) Water vapor in the gas stream (from Method 4 or alternative), proportion by volume (B_{ws}), measured at the frequency specified in the applicable regulation
- (b) Molecular weight of stack or duct gas, dry basis (M_d)
- (c) Molecular weight of stack or duct gas, wet basis (M_s)
- (d) Stack or duct static pressure (P_g)
- (e) Absolute stack or duct pressure (P_s)
- (f) Carbon dioxide concentration in the flue gas, dry basis (% $_d$ CO $_2$)
- (g) Oxygen concentration in the flue gas, dry basis (% $_d$ O $_2$)
- (h) Average axial stack or duct gas velocity ($v_{a(avg)}$) across all traverse points
- (i) Gas volumetric flow rate corrected to standard conditions, dry or wet basis as required by the applicable regulation (Q_{sd} or Q_{sw})

16.1.3.4 The following should be reported once per complete set of test runs:

- (a) Cross-sectional area of stack or duct at the test location (A)
- (b) Measurement system response time (sec)
- (c) Barometric pressure at measurement site (P_{bar})

16.1.4 Calibration data. The field test report should include calibration data for all probes and test equipment used in the field test. At a minimum, the probe calibration data reported to the Agency should include the following:

- (a) Date of calibration
- (b) Probe type
- (c) Probe identification number(s) or code(s)
- (d) Probe inspection sheets
- (e) Pressure measurements and intermediate calculations of F_1 and F_2 at each pitch angle used to obtain calibration curves in accordance with section 10.6 of this method
- (f) Calibration curves (in graphic or equation format) obtained in accordance with sections 10.6.11 of this method
- (g) Description and diagram of wind tunnel used for the calibration, including dimensions of cross-sectional area and position and size of the test section
- (h) Documentation of wind tunnel qualification tests performed in accordance with section 10.1 of this method

16.1.5 Quality Assurance. Specific quality assurance and quality control procedures used during the test should be described.

17.0 Bibliography

(1) 40 CFR Part 60, Appendix A, Method 1—Sample and velocity traverses for stationary sources.

(2) 40 CFR Part 60, Appendix A, Method 2H—Determination of stack gas velocity taking into account velocity decay near the stack wall.

(3) 40 CFR Part 60, Appendix A, Method 2—Determination of stack gas velocity and volumetric flow rate (Type S pitot tube).

(4) 40 CFR Part 60, Appendix A, Method 3—Gas analysis for carbon dioxide, oxygen, excess air, and dry molecular weight.

(5) 40 CFR Part 60, Appendix A, Method 3A—Determination of oxygen and carbon dioxide concentrations in emissions from stationary sources (instrumental analyzer procedure).

(6) 40 CFR Part 60, Appendix A, Method 4—Determination of moisture content in stack gases.

(7) Emission Measurement Center (EMC) Approved Alternative Method (ALT-011) "Alternative Method 2 Thermocouple Calibration Procedure."

(8) Electric Power Research Institute, Interim Report EPRI TR-106698, "Flue Gas Flow Rate Measurement Errors," June 1996.

(9) Electric Power Research Institute, Final Report EPRI TR-108110, "Evaluation of Heat Rate Discrepancy from Continuous Emission Monitoring Systems," August 1997.

(10) Fossil Energy Research Corporation, Final Report, "Velocity Probe Tests in Non-axial Flow Fields," November 1998, Prepared for the U.S. Environmental Protection Agency.

(11) Fossil Energy Research Corporation, "Additional Swirl Tunnel Tests: E-DAT and T-DAT Probes," February 24, 1999, Technical Memorandum Prepared for U.S. Environmental Protection Agency, P.O. No. 7W-1193-NALX.

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(13) National Institute of Standards and Technology, Special Publication 250, "NIST Calibration Services Users Guide 1991," Revised October 1991, U.S. Department of Commerce, p. 2.

(14) National Institute of Standards and Technology, 1998, "Report of Special Test of Air Speed Instrumentation, Four Prandtl Probes, Four S-Type Probes, Four French Probes, Four Modified Kiel Probes," Prepared for the U.S. Environmental Protection Agency under IAG #DW13938432-01-0.

(15) National Institute of Standards and Technology, 1998, "Report of Special Test of Air Speed Instrumentation, Five Autoprobes," Prepared for the U.S. Environmental Protection Agency under IAG #DW13938432-01-0.

(16) National Institute of Standards and Technology, 1998, "Report of Special Test of Air Speed Instrumentation, Eight Spherical Probes," Prepared for the U.S. Environmental Protection Agency under IAG #DW13938432-01-0.

(17) National Institute of Standards and Technology, 1998, "Report of Special Test of Air Speed Instrumentation, Four DAT Probes," Prepared for the U.S. Environmental Protection Agency under IAG #DW13938432-01-0.

(18) Norfleet, S.K., "An Evaluation of Wall Effects on Stack Flow Velocities and Related Overestimation Bias in EPA's Stack Flow Reference Methods," EPRI CEMS User's Group Meeting, New Orleans, Louisiana, May 13-15, 1998.

(19) Page, J.J., E.A. Potts, and R.T. Shigehara, "3-D Pitot Tube Calibration Study," EPA Contract No. 68-D1-0009, Work Assignment No. I-121, March 11, 1993.

(20) Shigehara, R.T., W.F. Todd, and W.S. Smith, "Significance of Errors in Stack Sampling Measurements," Presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Missouri, June 14-19, 1970.

(21) The Cadmus Group, Inc., May 1999, "EPA Flow Reference Method Testing and Analysis: Findings Report," EPA/430-R-99-009.

(22) The Cadmus Group, Inc., 1998, "EPA Flow Reference Method Testing and Analysis: Data Report, Texas Utilities, DeCordova Steam Electric Station, Volume I: Test Description and Appendix A (Data Distribution Package)," EPA/430-R-98-015a.

(23) The Cadmus Group, Inc., 1998, "EPA Flow Reference Method Testing and Analysis: Data Report, Texas Utilities, Lake Hubbard Steam Electric Station, Volume I: Test Description and Appendix A (Data Distribution Package)," EPA/430-R-98-017a.

(24) The Cadmus Group, Inc., 1998, "EPA Flow Reference Method Testing and Analysis: Data Report, Pennsylvania Electric Co., G.P.U. Genco Homer City Station: Unit 1, Volume I: Test Description and Appendix A (Data Distribution Package)," EPA/430-R-98-018a.

(25) The Cadmus Group, Inc., 1997, "EPA Flow Reference Method Testing and Analysis: Wind Tunnel Experimental Results," EPA/430-R-97-013.

18.0 Annexes

Annex A, C, and D describe recommended procedures for meeting certain provisions in sections 8.3, 10.4, and 10.5 of this method. Annex B describes procedures to be followed

when using the protractor wheel and pointer assembly to measure yaw angles, as provided under section 8.9.1.

18.1 Annex A—Rotational Position Check. The following are recommended procedures that may be used to satisfy the rotational position check requirements of section 8.3 of this method and to determine the angle-measuring device rotational offset R_{ADO} .

18.1.1 Rotational position check with probe outside stack. Where physical constraints at the sampling location allow full assembly of the probe outside the stack and insertion into the test port, the following procedures should be performed before the start of testing. Two angle-measuring devices that meet the specifications in section 6.2.1 or 6.2.3 are required for the rotational position check. An angle measuring device whose position can be independently adjusted (e.g., by means of a set screw) after being locked into position on the probe sheath shall not be used for this check unless the independent adjustment is set so that the device performs exactly like a device without the capability for independent adjustment. That is, when aligned on the probe such a device must give the same reading as a device that does not have the capability of being independently adjusted. With the fully assembled probe (including probe shaft extensions, if any) secured in a horizontal position, affix one yaw angle-measuring device to the probe sheath and lock it into position on the reference scribe line specified in section 6.1.6.1. Position the second angle-measuring device using the procedure in section 18.1.1.1 or 18.1.1.2.

18.1.1.1 Marking procedure. The procedures in this section should be performed at each location on the fully assembled probe where the yaw angle-measuring device will be mounted during the velocity traverse. Place the second yaw angle-measuring device on the main probe sheath (or extension) at the position where a yaw angle will be measured during the velocity traverse. Adjust the position of the second angle-measuring device until it indicates the same angle ($\pm 1^\circ$) as the reference device, and affix the second device to the probe sheath (or extension). Record the angles indicated by the two angle-measuring devices on a form similar to Table 2F-2. In this position, the second angle-measuring device is considered to be properly positioned for yaw angle measurement. Make a mark, no wider than 1.6 mm (1/16 in.), on the probe sheath (or extension), such that the yaw angle-measuring device can be re-affixed at this same properly aligned position during the velocity traverse.

18.1.1.2 Procedure for probe extensions with scribe lines. If, during a velocity traverse the angle-measuring device will be affixed to a probe extension having a scribe line as specified in section 6.1.6.2, the fol-

lowing procedure may be used to align the extension's scribe line with the reference scribe line instead of marking the extension as described in section 18.1.1.1. Attach the probe extension to the main probe. Align and lock the second angle-measuring device on the probe extension's scribe line. Then, rotate the extension until both measuring devices indicate the same angle ($\pm 1^\circ$). Lock the extension at this rotational position. Record the angles indicated by the two angle-measuring devices on a form similar to Table 2F-2. An angle-measuring device may be aligned at any position on this scribe line during the velocity traverse, if the scribe line meets the alignment specification in section 6.1.6.3.

18.1.1.3 Post-test rotational position check. If the fully assembled probe includes one or more extensions, the following check should be performed immediately after the completion of a velocity traverse. At the discretion of the tester, additional checks may be conducted after completion of testing at any sample port. Without altering the alignment of any of the components of the probe assembly used in the velocity traverse, secure the fully assembled probe in a horizontal position. Affix an angle-measuring device at the reference scribe line specified in section 6.1.6.1. Use the other angle-measuring device to check the angle at each location where the device was checked prior to testing. Record the readings from the two angle-measuring devices.

18.1.2 Rotational position check with probe in stack. This section applies only to probes that, due to physical constraints, cannot be inserted into the test port as fully assembled with all necessary extensions needed to reach the inner-most traverse point(s).

18.1.2.1 Perform the out-of-stack procedure in section 18.1.1 on the main probe and any attached extensions that will be initially inserted into the test port.

18.1.2.2 Use the following procedures to perform additional rotational position check(s) with the probe in the stack, each time a probe extension is added. Two angle-measuring devices are required. The first of these is the device that was used to measure yaw angles at the preceding traverse point, left in its properly aligned measurement position. The second angle-measuring device is positioned on the added probe extension. Use the applicable procedures in section 18.1.1.1 or 18.1.1.2 to align, adjust, lock, and mark (if necessary) the position of the second angle-measuring device to within $\pm 1^\circ$ of the first device. Record the readings of the two devices on a form similar to Table 2F-2.

18.1.2.3 The procedure in section 18.1.2.2 should be performed at the first port where measurements are taken. The procedure should be repeated each time a probe extension is re-attached at a subsequent port, unless the probe extensions are designed to be locked into a mechanically fixed rotational